WE CLAIM:

1. A method comprising:

transmitting a first signal comprising OFDM transmission units, each OFDM transmission unit comprising an OFDM symbol, and before/and/or/after the OFDM symbol a respective non-OFDM segment(s) containing known data and/or unknown highly reliable data, the non-OFDM segment allowing a conversion at a receiver between a linear convolution and a cyclic convolution for the OFDM symbol.

2. A method according to claim 1 wherein the non-OFDM segment of each OFDM symbol is at least long enough to cover any significant ISI introduced by a previous OFDM symbol.

3. A method according to claim 1 wherein the non-OFDM segment comprises a code separated pilot channel, signalling channel, and traffic channel.

4. A method according to claim 1 wherein the non-OFDM segment contains multiple channels which are time division multiplexed.

5. A method according to claim 4 wherein the multiple channels comprise a pilot channel time segment, signalling and traffic channel time segment during which the signalling and traffic channels are code separated, and another pilot channel segment in sequence.

6. A method according to claim 4 wherein the multiple channels comprise a traffic channel time segment, a pilot channel time segment and a signalling channel time segment in sequence.

7. A method according to claim 1 further comprising:

generating the OFDM symbols using fixed duration with varying IFFT size.

8. A method according to claim 1 further comprising:

generating the non-OFDM segments to have fixed durations with varying numbers of samples.

9. A method according to claim 1 wherein the first signal further comprises a guard time on either side of each prefix.

10. A method according to claim 1 wherein OFDM transmission units are embodied in slots which are 2048 chips in duration, and each slot comprising a first OFDM symbol which is 400 chips in duration followed by a 224 chip duration non-OFDM segment, followed by a second OFDM symbol and third OFDM symbol each of which are 400 chips in duration, followed by a 224 chip duration non-OFDM segment followed by a fourth OFDM symbol which is 400 chips in duration.

11. A method according to claim 10 wherein each non-OFDM segment comprises a 64 chip MAC segment, a 96 chip pilot segment and a 64 chip MAC segment in sequence.

12. A method according to claim 11 wherein the non-OFDM segments are fully compliant with 1xEV/DO forward link structure, and the first signal has a slot timing which is fully compliant with 1xEV/DO forward link structure.

13. A method according to claim 12 wherein each OFDM symbol is a 400 sub-carrier IFFT.

14. A method according to claim 12 wherein each OFDM symbol is a 208 sub-carrier IFFT.

15. A method according to claim 1 wherein said first signal is transmitted from a first antenna, the method further

comprising transmitting a second signal from a second antenna the second signal comprising OFDM transmission units each OFDM transmission unit comprising a respective OFDM symbol and before/and/or/after each OFDM symbol a respective non-OFDM segment containing known data and/or unknown highly reliable data, the non-OFDM segment allowing a conversion at a receiver between a linear convolution and a cyclic convolution.

16. A method according to claim 15 wherein each signal comprises slots which are 2048 chips in duration, and each slot comprising a first OFDM symbol which is 400 chips in duration followed by a 224 chip duration non-OFDM segment, followed by a second OFDM symbol and third OFDM symbol each of which are 400 chips in duration, followed by a 224 chip duration non-OFDM segment followed by a fourth OFDM symbol which is 400 chips in duration, the OFDM transmission units being embodied in the slots.

17. A method according to claim 16 wherein each non-OFDM segment comprises a 64 chip MAC segment, a 96 chip antenna specific pilot segment and a 64 chip MAC segment in sequence.

18. A method according to claim 17 wherein the non-OFDM segments are fully compliant with 1xEV/DO forward link structure, and the first signal has a slot timing which is fully compliant with 1xEV/DO forward link structure.

19. A method according to claim 1 further comprising:

transmitting as part of said first signal CDMA transmission units, each CDMA transmission unit comprising a CDMA data segment and containing before/and/or/after each CDMA data segment a respective non-OFDM segment containing known non-zero data and/or unknown highly reliable data;

wherein the signal contains a sequence of transmission units some of which are scheduled to be OFDM transmission units and some of which are scheduled to be CDMA transmission units.

20. A method according to claim 19 wherein the non-OFDM segments and CDMA data segments are fully backward compatible with existing IS-856 specifications.

21. A method according to claim 19 wherein the first signal comprises slots which are 2048 chips in duration, and each slot comprising a first data segment which is 400 chips in duration followed by a 224 chip duration non-OFDM segment, followed by a second data segment and third data segment each of which are 400 chips in duration, followed by a 224 chip duration non-OFDM segment followed by a fourth data segment which is 400 chips in duration wherein each of the data segments is scheduled to be either a CDMA data segment or an OFDM data segment, the sequence of transmission units being embodied in the slots.

22. A method according to claim 21 wherein each non-OFDM segment comprises a 64 chip MAC segment, a 96 chip pilot segment and a 64 chip MAC segment in sequence.

23. A method according to claim 1 further comprising:

transmitting data content of multiple users on the OFDM symbols.

24. A method according to claim 23 wherein for each user having data content on a given OFDM symbol a respective band of sub-carriers is used, the respective band comprising a subset of an overall OFDM sub-carrier set.

25. A method according to claim 24 further comprising:

for each user, performing frequency hopping of the respective band of sub-carriers.

26. A method according to claim 23 further comprising:

during the non-OFDM segments transmitting for each user a respective user specific pilot channel, the user specific pilot channels are overlapping in time but are orthogonal to each other.

27. A method according to claim 26 wherein:

the first signal comprises slots which are 2048 chips in duration, and each slot comprising a first OFDM symbol which is 400 chips in duration followed by a 224 chip duration non-OFDM segment, followed by a second OFDM symbol and third OFDM symbol each of which are 400 chips in duration, followed by a 224 chip duration non-OFDM segment followed by a fourth OFDM symbol which is 400 chips in duration, the OFDM transmission units being embodied in the slots.

28. A method according to claim 27 wherein each non-OFDM symbol comprises a 64 chip signalling segment, a respective 96 chip pilot segment for each user, and a 64 chip signalling segment in sequence, the pilot segments being overlaid in time and being orthogonal to each other.

29. A method according to claim 19 wherein the signal comprises an alternating sequence of CDMA transmission units and OFDM transmission units, the method further comprising performing power control over the CDMA transmission units.

30. A method according to claim 1 wherein the OFDM transmission units are embodied in a sequence comprising:

3 tail bits;

a 58 point IDFT as an OFDM symbol;

26 bit training sequence;

a second 58 point IDFT as another OFDM symbol;

3 tail bits;

an 8.25 bit duration guard period wherein the tail bits and or the training sequence function as the non-OFDM segment.

31. A method according to claim 1 further comprising:

transmitting as part of said signal GSM transmission units, wherein the signal contains a sequence of transmission units some of which are scheduled to be OFDM transmission units and some of which are scheduled to be CDMA transmission units;

wherein the transmission units are embodied in a sequence comprising:

3 tail bits;

a 58 point IDFT as an OFDM symbol for an OFDM transmission unit, or 57 bits of data and a one bit stealing flag for a GSM transmission unit;

26 bit training sequence;

a second 58 point IDFT as another OFDM symbol for an OFDM transmission unit or 57 bits of data and a one bit stealing flag for a GSM transmission unit;

3 tail bits;

an 8.25 bit duration guard period wherein the tail bits and or the training sequence function as non-OFDM segment.

32. A method according to claim 1 wherein the first signal comprises 15 slot frames, the first signal comprising a

primary SCH, secondary SCH, pilot channel, and dedicated channel overlaid together as a CDMA signal, the CDMA signal being overlaid in time with said OFDM symbols.

33. A method according to claim 32 wherein portions of said CDMA signals function as said non-OFDM segments.

34. A method according to claim 32 wherein during each slot, the first signal comprises two OFDM transmission units, each OFDM transmission unit comprising a 128 chip prefix, a 1024 point IFFT, and a 128 chip suffix.

35. A method according to claim 34 wherein each 28 chip prefix contains a designed training sequence, and each 128 chip suffix contains system information, broadcast information or short messaging information.

36. A method according to claim 32 wherein during each slot, the first signal comprises one OFDM transmission unit, each OFDM transmission unit comprising a 128 chip prefix, a 2024 point IFFT, and a 128 chip suffix.

37. A method according to claim 1 for use with a UMTS downlink modified to include an OFDM overlay.

38. A method according to claim 1 adapted for use with IEEE-802.11 a/g system with a variable non-OFDM segment and/or blind non-OFDM segment detection.

39. A method according to claim 1 adapted for use with IEEE 802.16a systems.

40. A method of processing a received signal containing a signal containing OFDM transmission units, each OFDM transmission unit containing an OFDM symbol and also containing before/and/or/after each OFDM symbol a respective prefix containing known non-zero data and/or unknown highly reliable

data after having been transmitted over a multi-path channel, the method comprising:

converting received samples of each OFDM symbol to a respective new set of received samples such that the new set of received samples is mathematically equal to the transmitted samples cyclically convoluted with the channel response of the multi-path channel such that the frequency domain convolution theorem holds true.

41. A method according to claim 40 further comprising:

performing finger searching and channel estimation based on the non-OFDM segments to generate for each non-OFDM segment a respective time domain channel estimate;

performing an FFT function on each time domain channel estimate to generate a respective frequency domain channel estimate;

performing time frequency interpolation upon multiple frequency domain channel estimates to generate a current frequency domain channel estimate.

42. A method according to claim 41 further comprising:

performing an IFFT on the frequency domain channel estimate to get another time domain channel estimate;

using the time domain channel estimate to perform finger searching and channel estimating in the time domain to get a new improved time domain channel estimate;

performing the FFT and time frequency interpolation steps again on the improved time domain channel estimate to get an improved current frequency domain channel estimate.

43. A method according to claim 41 further comprising:

demodulating contents of the non-OFDM segment using the time domain channel estimate.

44. A method according to claim 42 further comprising:

demodulating contents of the non-OFDM segment using the improved time domain channel estimate.

45. A method according to claim 41 further comprising:

performing demodulation of a current OFDM symbol using the frequency domain channel estimate.

46. A method according to claim 41 further comprising:

performing demodulation of a current OFDM symbol using the improved frequency domain channel estimate.

47. A method according to claim 32 further comprising performing channel estimation to recover a discretized time domain channel estimate by:

for a first non-OFDM segment containing J known or highly reliable samples, followed by an OFDM symbol, followed by a second non-OFDM segment containing J (or another number) known or highly reliable samples, defining a plurality of equations relating received samples during the first and second non-OFDM segments to corresponding known/highly reliable values as a function of L samples of a discretized channel response, and solving the equations for the L samples of the discretized channel response, where there are at least L equations.

48. A method according to claim 47 further comprising performing an FFT on the discretized channel response to generate a frequency domain channel response.

49. A method according to claim 47 further comprising:

demodulating contents of the non-OFDM segments using the time domain channel estimate.

50. A method according to claim 47 further comprising:

demodulating contents of the prefix using the improved time domain channel estimate.

51. A method according to claim 40 further comprising:

determining a frequency domain channel estimate;

dividing the new set of received samples by the frequency domain channel estimate on a per-sub-carrier basis.

52. A method according to claim 40 wherein converting received samples of each OFDM symbol to a respective new set of received samples such that the new set of received samples is mathematically equal to the transmitted samples cyclically convoluted with the channel response of the multi-path channel such that the frequency domain convolution theorem holds true comprises:

defining (L-1)x(L-1) upper and lower matrices U and W, respectively, as

$$U=\begin{bmatrix} h(L-1) & h(L-2) & \ldots & h(1) \\ 0 & h(L-1) & \ldots & h(2) \\ \ldots & \ldots & \ldots & \ldots \\ 0 & 0 & \ldots & h(L-1) \end{bmatrix}, W=\begin{bmatrix} h(0) & 0 & \ldots & 0 \\ h(1) & h(0) & \ldots & 0 \\ \ldots & \ldots & \ldots & \ldots \\ h(L-2) & h(L-3) & \ldots & h(0) \end{bmatrix}$$

and defining the new set of samples y(0), y(1), …, y(L-2) as

$$\begin{bmatrix} y(0) \\ y(1) \\ \vdots \\ y(L-2) \end{bmatrix} = \begin{bmatrix} y(0) \\ y(1) \\ \vdots \\ y(L-2) \end{bmatrix} - U\begin{bmatrix} a(1) \\ a(2) \\ \vdots \\ a(L-1) \end{bmatrix} + \begin{bmatrix} z(0) \\ z(1) \\ \vdots \\ z(L-2) \end{bmatrix} - W\begin{bmatrix} b(0) \\ b(1) \\ \vdots \\ b(L-2) \end{bmatrix}$$

where h(.) is a discretized channel response, a(.) are known or highly reliable values for a non-OFDM period preceding the OFDM symbol, b(.) are known or highly reliable values for a non-OFDM period following the OFDM symbol, z(.) are received values for the non-OFDM period following the OFDM symbol, y(.) on the right hand side of the equation are received samples of the OFDM symbol, and y(.) on the left hand side of the equation are the new set of received samples.

53. A method of converting a linear convolution to a cyclic convolution for a received OFDM symbol comprising:

defining (L-1)x(L-1) upper and lower matrices U and W, respectively, as

$$U = \begin{bmatrix} h(L-1) & h(L-2) & \dots & h(1) \\ 0 & h(L-1) & \dots & h(2) \\ \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & h(L-1) \end{bmatrix}, W = \begin{bmatrix} h(0) & 0 & \dots & 0 \\ h(1) & h(0) & \dots & 0 \\ \dots & \dots & \dots & \dots \\ h(L-2) & h(L-3) & \dots & h(0) \end{bmatrix}$$

and defining the new set of samples y(0), y(1), …, y(L-2) as

$$\begin{bmatrix} y(0) \\ y(1) \\ \vdots \\ y(L-2) \end{bmatrix} = \begin{bmatrix} y(0) \\ y(1) \\ \vdots \\ y(L-2) \end{bmatrix} - U\begin{bmatrix} a(1) \\ a(2) \\ \vdots \\ a(L-1) \end{bmatrix} + \begin{bmatrix} z(0) \\ z(1) \\ \vdots \\ z(L-2) \end{bmatrix} - W\begin{bmatrix} b(0) \\ b(1) \\ \vdots \\ b(L-2) \end{bmatrix}$$

where h(.) is a discretized channel response, a(.) are known or highly reliable values for a non-OFDM period preceding the OFDM symbol, b(.) are known or highly reliable values for a non-OFDM period following the OFDM symbol, z(.) are received values for the non-OFDM period following the OFDM symbol, y(.) on the right hand side of the equation are received samples of the OFDM symbol, and y(.) on the left hand side of the equation are the new set of received samples.

54. A transmitter comprising:

a first transmit antenna;

OFDM signal generating circuitry for generating OFDM symbols for transmission;

non-OFDM signal generating circuitry for generating non-OFDM segments;

wherein the OFDM signal generating circuitry and the non-OFDM signal generating circuitry are adapted to generate and transmit through the first transmit antenna a first signal comprising OFDM transmission units, each OFDM transmission unit comprising an OFDM symbol, and before/and/or/after the OFDM symbol a respective non-OFDM segment(s) containing known data and/or unknown highly reliable data, the non-OFDM segment allowing a conversion at a receiver between a linear convolution and a cyclic convolution for the OFDM symbol.

55. A transmitter according to claim 54 wherein the non-OFDM segment of each OFDM symbol is at least long enough to cover any significant ISI introduced by a previous OFDM symbol.

56. A transmitter according to claim 54 wherein the non-OFDM segment comprises a code separated pilot channel, signalling channel, and traffic channel.

57. A transmitter according to claim 54 wherein the non-OFDM segment contains multiple channels which are time division multiplexed.

58. A transmitter according to claim 57 wherein the multiple channels comprise a pilot channel time segment, signalling and traffic channel time segment during which the signalling and traffic channels are code separated, and another pilot channel segment in sequence.

59. A transmitter according to claim 57 wherein the multiple channels comprise a traffic channel time segment, a pilot channel time segment and a signalling channel time segment in sequence.

60. A transmitter according to claim 57 adapted to generate the OFDM symbols using fixed duration with varying IFFT size.

61. A transmitter according to claim 54 wherein OFDM transmission units are embodied in slots which are 2048 chips in duration, and each slot comprising a first OFDM symbol which is 400 chips in duration followed by a 224 chip duration non-OFDM segment, followed by a second OFDM symbol and third OFDM symbol each of which are 400 chips in duration, followed by a 224 chip duration non-OFDM segment followed by a fourth OFDM symbol which is 400 chips in duration.

62. A transmitter according to claim 54 wherein each non-OFDM segment comprises a 64 chip MAC segment, a 96 chip pilot segment and a 64 chip MAC segment in sequence.

63. A transmitter according to claim 62 wherein the non-OFDM segments are fully compliant with 1xEV/DO forward link structure, and the first signal has a slot timing which is fully compliant with 1xEV/DO forward link structure.

64. A transmitter according to claim 54 wherein the non-OFDM signal generating circuitry comprises CDMA signal generation circuitry adapted to transmit as part of said first signal CDMA transmission units, each CDMA transmission unit comprising a CDMA data segment and containing before/and/or/after each CDMA data segment a respective non-OFDM segment containing known non-zero data and/or unknown highly reliable data;

wherein the first signal contains a sequence of transmission units some of which are scheduled to be OFDM transmission units and some of which are scheduled to be CDMA transmission units.

65. A transmitter according to claim 54 wherein the OFDM transmission units are embodied in a sequence comprising:

3 tail bits;

a 58 point IDFT as an OFDM symbol;

26 bit training sequence;

a second 58 point IDFT as another OFDM symbol;

3 tail bits;

an 8.25 bit duration guard period wherein the tail bits and or the training sequence function as the non-OFDM segment.

66. A transmitter according to claim 54 wherein:

the non-OFDM signal generating circuitry comprises GSM signal generating circuitry adapted to transmit as part of said signal GSM transmission units, wherein the signal contains a sequence of transmission units some of which are scheduled to

be OFDM transmission units and some of which are scheduled to be CDMA transmission units;

wherein the transmission units are embodied in a sequence comprising:

3 tail bits;

a 58 point IDFT as an OFDM symbol for an OFDM transmission unit, or 57 bits of data and a one bit stealing flag for a GSM transmission unit;

26 bit training sequence;

a second 58 point IDFT as another OFDM symbol for an OFDM transmission unit or 57 bits of data and a one bit stealing flag for a GSM transmission unit;

3 tail bits;

an 8.25 bit duration guard period wherein the tail bits and or the training sequence function as non-OFDM segment.

67. A transmitter according to claim 54 for use with a UMTS downlink modified to include an OFDM overlay.

68. A transmitter according to claim 54 adapted for use with IEEE-802.11 a/g system with a variable non-OFDM segment and/or blind non-OFDM segment detection.

69. A transmitter according to claim 54 adapted for use with IEEE 802.16a systems.

70. A transmitter according to claim 54 wherein the non-OFDM signal generation circuitry comprises 1xEV/DO signal generation circuitry.

71. A transmitter according to claim 54 further comprising:

a second transmit antenna;

wherein the OFDM signal generation circuitry and the non-OFDM signal generation circuitry are further adapted to generate and transmit through the second antenna a second signal comprising OFDM transmission units each OFDM transmission unit comprising a respective OFDM symbol and before/and/or/after each OFDM symbol a respective non-OFDM segment containing known data and/or unknown highly reliable data, the non-OFDM segment allowing a conversion at a receiver between a linear convolution and a cyclic convolution.

72. A transmitter according to claim 54 wherein the non-OFDM signal generating circuitry is compatible with IS-856 specifications.

73. A transmitter according to claim 54 wherein the non-OFDM signal generating circuitry is compatible with GSM specifications.

74. A receiver adapted to process a received signal containing a signal containing OFDM transmission units, each OFDM transmission unit containing an OFDM symbol and also containing before/and/or/after each OFDM symbol a respective prefix containing known non-zero data and/or unknown highly reliable data after having been transmitted over a multi-path channel, by converting received samples of each OFDM symbol to a respective new set of received samples such that the new set of received samples is mathematically equal to the transmitted samples cyclically convoluted with the channel response of the multi-path channel such that the frequency domain convolution theorem holds true.

75. A receiver according to claim 74 further comprising:

finger searches and channel estimation circuitry for performing finger searching and channel estimation based on the non-OFDM segments to generate for each non-OFDM segment a respective time domain channel estimate;

an FFT circuit for performing an FFT function on each time domain channel estimate to generate a respective frequency domain channel estimate;

a time frequency interpolator for performing time frequency interpolation upon multiple frequency domain channel estimates to generate a current frequency domain channel estimate.

76. A receiver according to claim 75 further comprising:

an IFFT circuit for performing an IFFT on the frequency domain channel estimate to get another time domain channel estimate;

wherein the finger searching and channel estimation circuitry uses the time domain channel estimate to perform finger searching and channel estimating in the time domain to get a new improved time domain channel estimate;

wherein the FFT circuit performs the FFT function again and the time frequency interpolator performs the time frequency interpolation steps again on the improved time domain channel estimate to get an improved current frequency domain channel estimate.

77. A receiving according to claim 75 further comprising:

a demodulator for demodulating contents of the non-OFDM segment using the time domain channel estimate.

78. A method according to claim 74 wherein converting received samples of each OFDM symbol to a respective new set of

received samples such that the new set of received samples is mathematically equal to the transmitted samples cyclically convoluted with the channel response of the multi-path channel such that the frequency domain convolution theorem holds true comprises:

defining (L-1)x(L-1) upper and lower matrices U and W, respectively, as

$$U=\begin{bmatrix} h(L-1) & h(L-2) & \dots & h(1) \\ 0 & h(L-1) & \dots & h(2) \\ \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & h(L-1) \end{bmatrix}, W=\begin{bmatrix} h(0) & 0 & \dots & 0 \\ h(1) & h(0) & \dots & 0 \\ \dots & \dots & \dots & \dots \\ h(L-2) & h(L-3) & \dots & h(0) \end{bmatrix}$$

and defining the new set of samples y(0), y(1), …, y(L-2) as

$$\begin{bmatrix} y(0) \\ y(1) \\ \vdots \\ y(L-2) \end{bmatrix} = \begin{bmatrix} y(0) \\ y(1) \\ \vdots \\ y(L-2) \end{bmatrix} - U\begin{bmatrix} a(1) \\ a(2) \\ \vdots \\ a(L-1) \end{bmatrix} + \begin{bmatrix} z(0) \\ z(1) \\ \vdots \\ z(L-2) \end{bmatrix} - W\begin{bmatrix} b(0) \\ b(1) \\ \vdots \\ b(L-2) \end{bmatrix}$$

where h(.) is a discretized channel response, a(.) are known or highly reliable values for a non-OFDM period preceding the OFDM symbol, b(.) are known or highly reliable values for a non-OFDM period following the OFDM symbol, z(.) are received values for the non-OFDM period following the OFDM symbol, y(.) on the right hand side of the equation are received samples of the OFDM symbol, and y(.) on the left hand side of the equation are the new set of received samples.